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Update on the standoff detection of radiological materials by passive FTIR radiometry

2006-2007 summary report for the Canadian Safeguards Support Program of the Canadian Nuclear Safety Commission

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Defence R&D Canada – Valcartier

Technical Note

DRDC Valcartier TN 2007-095

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Canada

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Summary

This year's activities were centred on four major objectives:

(1) In collaboration with DRDC Ottawa, a field trial was planned for Spring 2006 at DRDC Ottawa that would involve the use of ground-based passive standoff FTIR radiometry for detecting and identifying UO2 and U3O8 radioactive materials at standoff distances of 30 and 100 m. This would be the first time that actual radioactive materials have been measured in the open using the passive remote sensing radiometric technique.

(2) In a potential collaboration with Cameco Corp., several uranium oxide materials (including processed and non-processed uranium ores) and waste materials from the milling and processing operations were to be measured using passive thermal radiometry and VNIR and SWIR spectroscopic techniques. These ground-based measurement results would be analysed to determine the possibility of using these sensing techniques for the detection and identification of materials specific to uranium mining processes.

(3) Dependant on funding, the AIRIS sensor would be deployed to measure radiological materials at altitudes of 1 km. The availability of the AIRIS sensor was subject to budgetary approval from another program.

(4) Various national/international meetings and workshops to support further development of the passive remote sensing FTIR technique.

<u>Collaboration with DRDC Ottawa</u>

The collaboration with DRDC Ottawa continues; however, much of the effort over the past year has been on planning the field experiments. Due to the fact that these experiments involve radiological materials, extraordinary precautions must be undertaken in the planning and experimental process. We envision having these plans in place early in 2007 in order to carry out the initial experiments in the summer of 2007.

Some important experimental planning problems have been solved, which consist of sealing the radiological sources with a thin layer of polyethylene. Sealing the sources will mitigate any environmental or health hazard posed by the radiological materials. A preliminary experiment was designed to investigate what effect the plastic layer may have on the standoff detection of an underlying chemical powder. Sand (SiO_2), which was used to simulate a radiological powder, was spread in a thin layer on an aluminum plate as shown in Fig. 1A. The sand was then covered with a 1-mil thick layer of polyethylene, as shown in Fig. 1B. The

sand/polyethylene plate was placed outdoors and imaged with the CATSI instrument via a folding mirror, as shown in Figure 2.

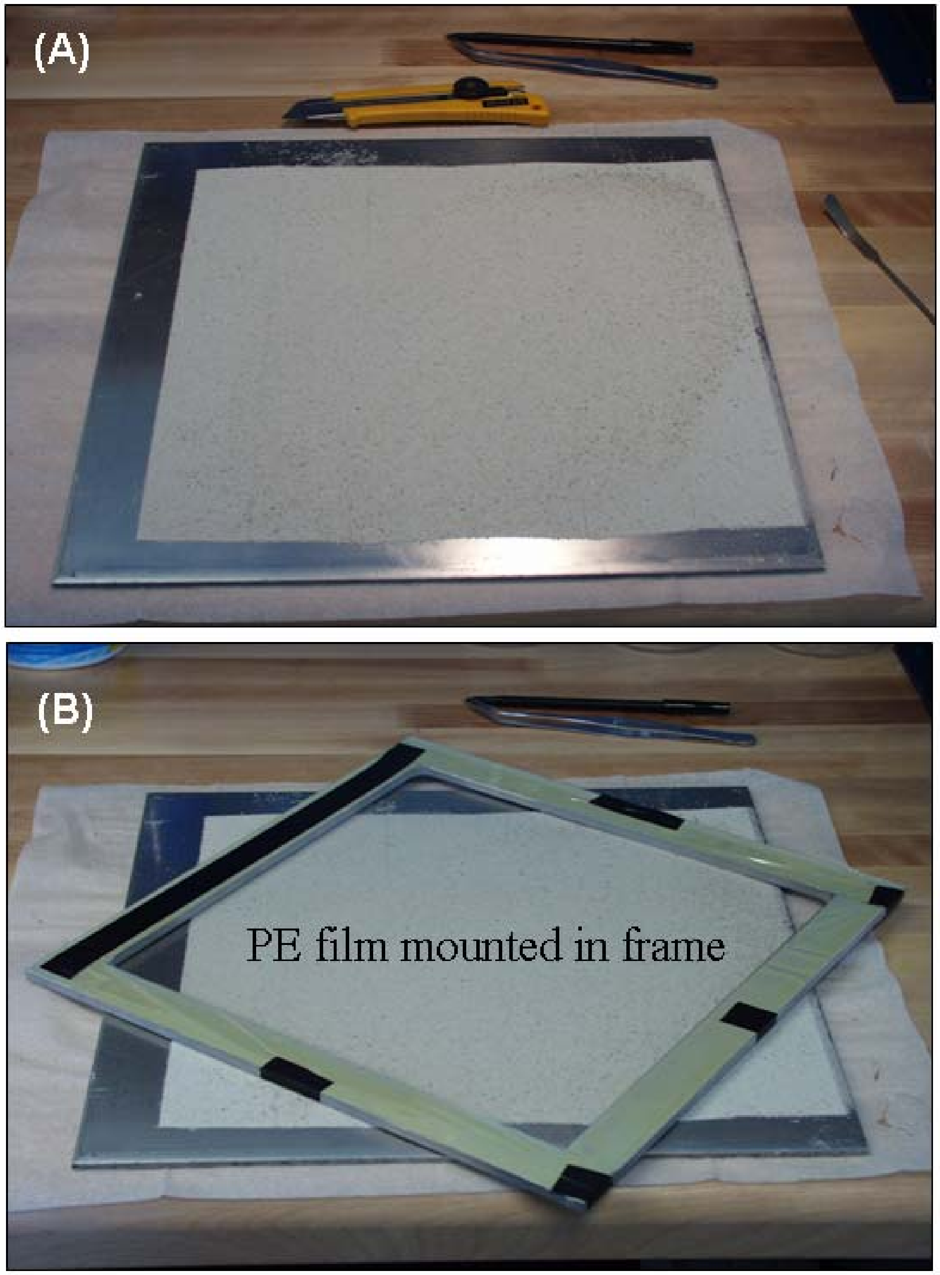

Figure 1: (A) Aluminum plate covered with a thin layer of sand (radiological simulant). (B) Polyethylene (PE) plastic layer used to cover sand.

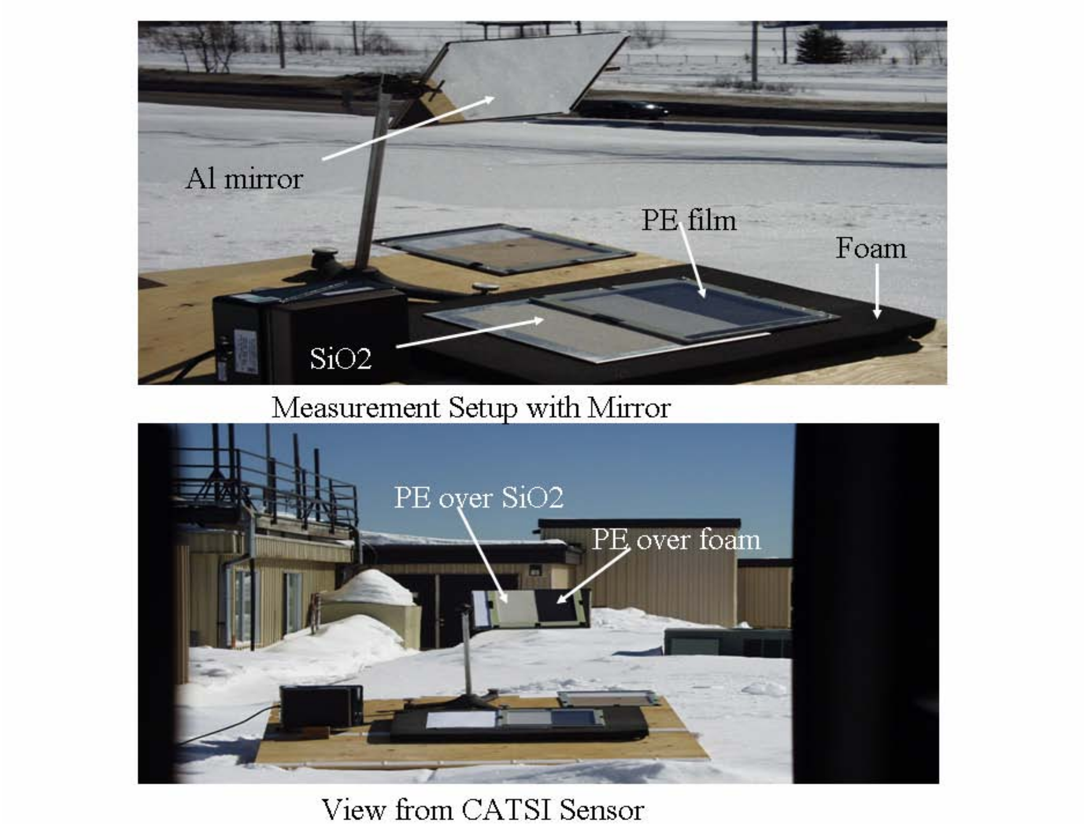

Figure 2: Tray containing sand (SiO_2) covered with PE placed in outdoor environment and measured with the CATSI sensor.

The clear blue sky provided the necessary thermal contrast in order to observe the spectral features of the SiO_2 powder. A black background was used to provide a reference spectrum without spectral features. Measurement results of the SiO_2 powder were obtained with and without the plastic layer, as shown in Fig. 3. The gray curve shows the emissivity spectrum of pure SiO_2 and its identifying features at 800 and 1100 – 1200 cm^{-1}. The black curve shows the differential radiance from SiO_2 powder without the plastic layer, as measured with the CATSI instrument. This measurement is the difference between the radiance measured from the SiO_2 and the black background. Its signature is consistent with the emissivity of the pure powder. The measurement was repeated with the plastic layer in place. The result, shown by the red curve, indicates that the SiO_2 signature can still be identified. A small spectral feature from the polyethylene film is also present at 720 cm^{-1}; however, this does not adversely impact the detection of the underlying SiO_2 powder.

This work shows that a plastic film can be used to seal the real radioactive materials, which will mitigate any potential environmental or health hazard during an open-air experiment to be performed later in 2007.

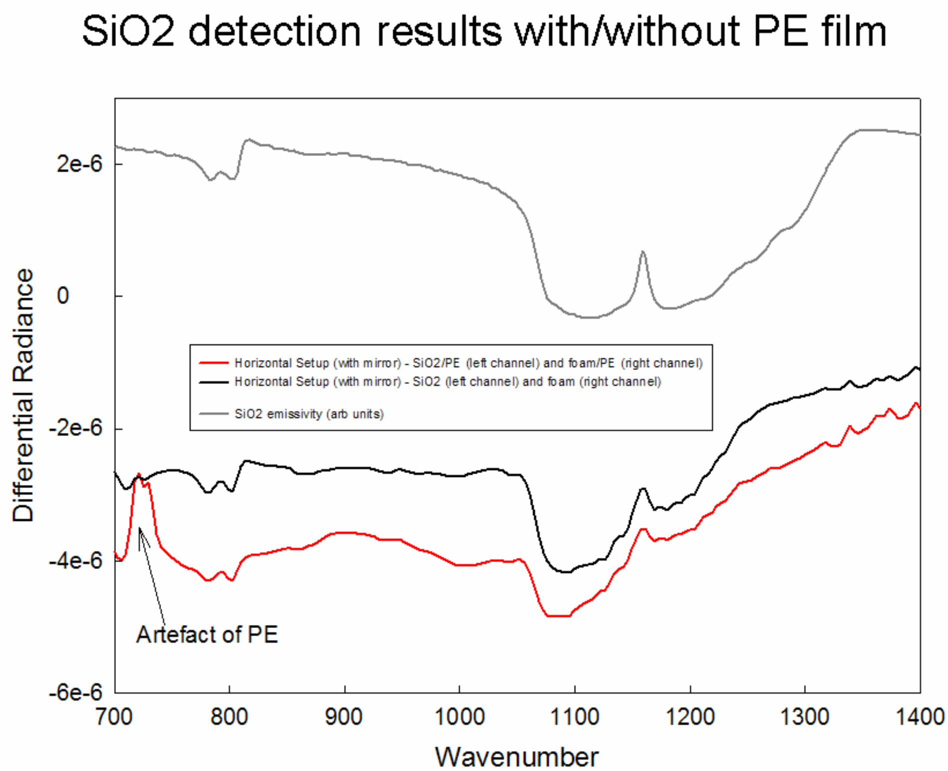

Figure 3: Spectral features of sand (SiO_2). The upper gray curve shows the emissivity features for pure SiO_2. The black curve represents the spectrum of SiO_2 measured with the CATSI instrument without the plastic film in place. The red curve represents the spectrum of SiO_2 measured with the CATSI instrument with the polyethylene plastic film in place.

Other Collaborative Objectives

Concerning the other objectives listed above, a remote sensing experiment was carried out at Key Lake this past year; however, those results have since become classified. Some of this information was reported in one classified meeting this year and may be shared with CSSP in the coming year for Canadian use only.

Due to lack of funding, the AIRIS airborne sensor was not incorporated in any measurement campaigns this past year. It is our intention to resume flights next year, subject to available funding.

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